Assessment of Environmental Pollution and Community Health in Northwest Florida

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BACKGROUND

Escambia and Santa Rosa Counties are the two most western counties in the state of Florida. In 2000, the combined population of Santa Rosa and Escambia Counties was 412,000 people. Escambia County had grown 12% since 1990 while Santa Rosa has seen a 43% increase since 1990 (US Census Bureau; http://quickfacts.census.gov/). This two- county area is bound on the north and west by Alabama, on the east by Okaloosa County, FL, and on the south by the Gulf of Mexico. Escambia County is separated from Santa Rosa County by the Escambia River and from Alabama by the Perdido River. The area is rich in history and natural resources including beaches, estuaries, coastal dunes, and inland forests. This region is situated in the Coastal Plains physiographic province of the Florida Panhandle. Most of the region consists of relatively flat plateaus that are ideal for agriculture. Pensacola Bay and Perdido Bay are the two estuarine systems that dominate the region and all significant activity in the area, past or present, has depended on these resources (Grand Jury Report, 1999). Numerous streams form drainage networks from the plateaus to the rivers. Pond and Big Coldwater creeks are the two principal streams of Santa Rosa County, flowing southward into the Blackwater River which empties into East Bay. In addition, the Yellow River drains a small portion of south Santa Rosa County and also flows into East Bay. The largest stream in the area is the Escambia River which flows southward from Alabama and empties into Escambia Bay. The Perdido River also flows southward along the Florida-Alabama boarder and empties into Perdido Bay (Knight et al.,1996). The combined area is composed of 1667 square miles of land and 212 square miles of water. Land use is dominated by upland forests (56%), wetlands (19%), and agriculture (11%). Seven percent is residential and 1% is commercial (Grand Jury Report, 1999).

The 1999 EPA Toxic Release Inventory (http://www.epa.gov/tri/) listed 23 industries for Escambia County and 5 for Santa Rosa County (Fig. 1). Toxic chemicals released into the region in 1999 amounted to 52.2 million pounds from Escambia County and 1.25 million pounds from Santa Rosa County, which ranks Escambia County as the 18th highest toxic releasing county in the country.

There are eight Superfund Sites in the region (Fig. 1) that are in different stages of site evaluation and remediation. One of these sites, Escambia Treating Company (ETC), was part of a National Relocation Evaluation Pilot effort and involved relocation of 358 households from the site. The health concerns of the affected residents, and evidence of ground water contamination emanating from some of the Superfund sites are of concern to the community.

In 1998, the Chief Judge of the First Judicial Circuit of the State of Florida impaneled a Special Grand Jury in Escambia County, at the request of the State Attorney, to examine air and water quality in northwest Florida. This group heard testimony from over 100 hundred witnesses and reviewed hundreds of pertinent documents and reports. The jury's conclusions were that surface waters are generally degraded, primarily due to industry discharges, sewage treatment and stormwater runoff. Groundwater supplies have been widely contaminated by poor practices by industry and will continue to be contaminated. Air quality has deteriorated and is unlikely to improve unless changes are made in industry discharges (Grand Jury Report, 1999).

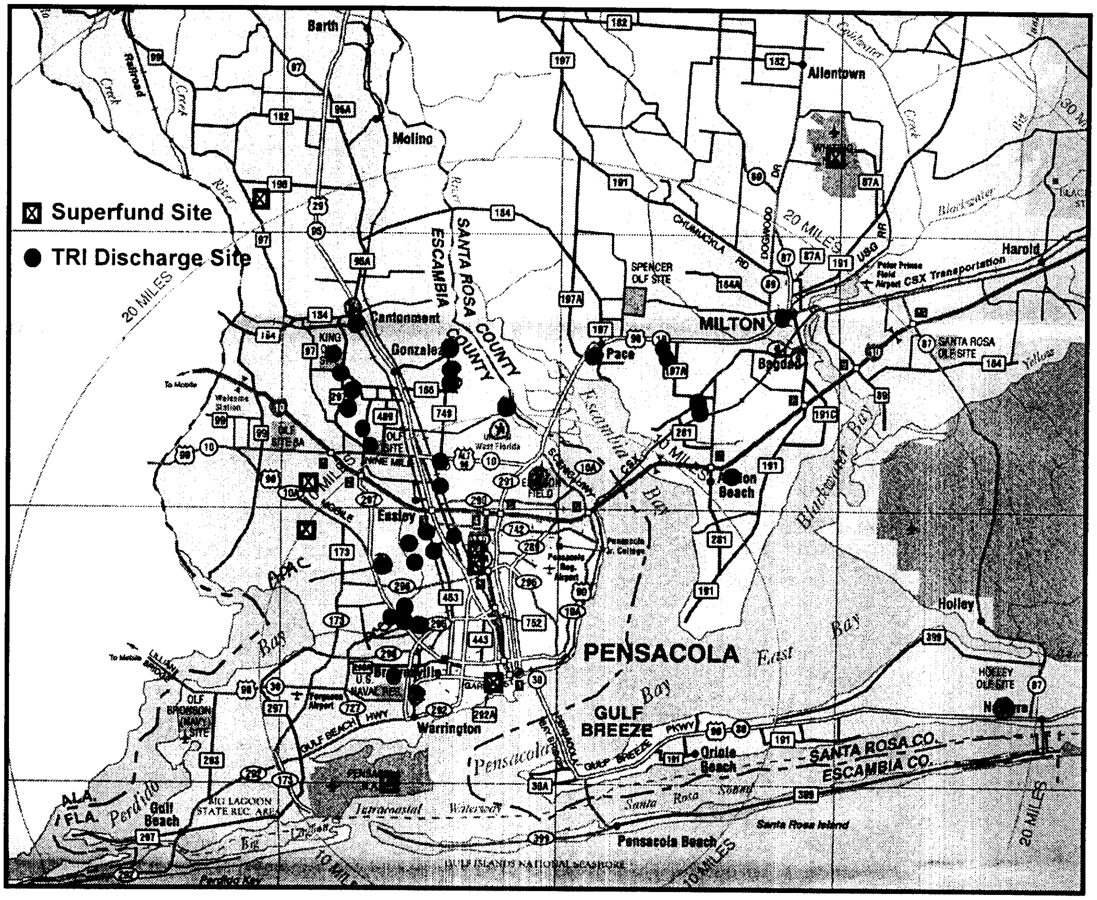

Figure 1. Escambia and Santa Rosa County: location of Superfund Sites and TRI Discharge Sites.

In 2000, Partnership for a Healthy Community sponsored a study entitled *Comprehensive Assessment for Tracking Community Health* (CATCH) for Escambia and Santa Rosa Counties (Studnicki 2001a,b). The study was conducted to provide residents information on key health indicators for the area. There were 250 indicators analyzed for 1994-1998 which were subsequently grouped into nine categories and comparisons made to other similar counties in Florida, State of Florida averages, and US Department of Health and Human Services standards in *Healthy People 2010*. In summary, nearly 40% of the indicators for Escambia County were unfavorable while 32% were unfavorable in Santa Rosa County. For example, cardiovascular disease age-adjusted mortality rates are high for both counties and heart disease is high in Escambia County. Rates of all cancers for Escambia County are higher than averages for peer counties and the state. Santa Rosa County has higher rates of strokes than for its peer counties and the state of Florida. The rate of birth defects mortality in Santa Rosa County is almost twice the rates for both peer counties and the Florida average.

There is considerable public concern over whether local environmental conditions are leading to deteriorating public health, and on the potential impact of such conditions on the quality of life and economic development in the area, as highlighted in a series of articles published in the Pensacola News Journal (e.g. Streater, 2001). In response to these public concerns the United States Congress appropriated funding ($850,000) to the University of West Florida to launch studies to determine if a connection exists between elevated levels of illness in Northwest Florida and the levels of the toxic pollutants in the area. The University relegated the responsibility of these studies to the Center for Environmental Diagnostics and Bioremediation, with the center's director as Project Director.

In view of the community interest in the project and in order to provide a forum for input and exchange of information, the Project Director established an advisory committee composed of 25 members to include representatives of city and county governments (e.g., Pensacola, Milton, Navarre Beach, Escambia County, Santa Rosa County), Escambia County Utilities Authority, Northwest Florida Water Management District, Florida Department of Environmental Protection, Florida Department of Health, and U.S. Environmental Protection Agency (Gulf Ecology Division, NHEERL), as well as representatives of industries, professional organizations, and environmental advocacy groups. The Project Director convened several meetings of this advisory committee during March 2002 to seek input on current knowledge and prioritized needs pertinent to the assessment of environmental and community health in Northwest Florida. Additional follow-up discussions were held with representatives of many of the above organizations, as well as representatives of Navy and Air Force facilities, to ensure that the objectives and expected outcomes of the present project would be beneficial for addressing regional environmental and health concerns.

Preliminary evaluation of the available information on environmental and community health in Northwest Florida, input from the regional advisory committee, and discussions with technical/scientific staff at EPA Region IV lead to the following conclusions. Information on the nature and levels of toxic pollutants in the Northwest Florida area is scattered, difficult to locate, and incomplete. In considering the potential impacts of pollutants on the community at large, much remains to be known about exposure risks to environmental pollutants, including air pollutants. Although more comprehensive assessments of environmental pollution are needed, the available information is amenable for use in conjunction with data on health indicators to determine whether any components of variation in community health status would statistically correlate with hazardous exposure levels of environmental pollutants. The potential risks of multiple sources of toxic pollutants to water quality and community health also merits further evaluation, with Bayou Texar serving as a model system for such an assessment. Based on these considerations, we propose the following work plan with five defined tasks. The University of West Florida will perform this work in collaboration with subgrantees at the University of South Florida and Georgia Institute of Technology. Both subgrantees will meet the same grant requirements as the prime grantee, University of West Florida. The rationale, objectives, work plans, outcomes, and deliverables for each task are described below.

SCOPE OF WORK

Task 1. Construction of an Environmental Bibliography for Northwest Florida.

(PI: W.H. Jeffrey, University of West Florida)

In June 1999, the special Grand Jury on Air and Water Quality (Grand Jury Report) impaneled by the Chief Judge of the First Judicial Circuit of the State of Florida reported that "many independent, separate, and often redundant, studies have been made of various aspects of the area air and water." These redundant studies have, in part, hampered the ability to identify and regulate environmental concerns in the Escambia/Santa Rosa County areas of Northwest Florida. Part of the problem stems from the fact that each agency has operated independently of the others without good coordination and communication. In most cases, agencies and groups have not been aware of what research studies and reports have been completed by others. In the

Pensacola area, environmental reports and studies are likely to have been completed by a wide variety of groups as described in Table 1.

Table 1. List of Potential Agencies with Environmental Publications & Reports regarding Escambia and Santa Rosa Counties Air, Water and Land

United States Environmental Protection Agency
Florida Department of Environmental Protection
Northwest Florida Water Management District
Escambia County Utilities Authority
United States Geological Survey
Army Corps of Engineers
City of Pensacola
Escambia County Government
Santa Rosa County Government
City of Gulf Breeze
City of Milton
South Santa Rosa Utilities Authority
National Oceanic and Atmospheric Administration
United States Fish and Wildlife Service
National Wetlands Research Center
Escambia County Health Department
Santa Rosa County Health Department
Florida Game and Fresh Water Fish Commission
United States Navy
United States Air Force
United States Department of Energy
Minerals Management Service
Private Industry
Southern Company (Gulf Power)
Solutia
Air Products
International Paper
Reichhold Chemical
Conoco

The last complete bibliography of Environmental Research compiled for this area was completed in 1985 (Means and McErlean, 1987). Since its completion, environmental concerns have moved to the forefront of local interests (Grand Jury Report). As a result, it is apparent that a new up-to-date Environmental Bibliography must be compiled so that all local agencies and concerned citizens may be better informed about what specific studies have been conducted in the area.

Objectives & Work Plan
Literature databases from each of the above listed groups (as well as others to be identified) will be examined and reports concerning environmental issues and research in Northwest Florida will be identified and entered into a database (tentatively to be compiled using the software program *Endnote* (ISI Research, Berkeley, CA). Each reference will be annotated regarding location of the original, its format (paper, CD, web, etc.), the type of report (e.g. peer reviewed literature, government "gray" literature, technical report, newspaper report, etc.), and a brief synopsis of the document's purpose and findings. When possible, an evaluation of the quality or applicability of the reference or data to the present study will be included. The completed bibliography will be posted on the internet via the University of West Florida's server. In addition, it will be converted to Microsoft Access to create a searchable database that can also be accessed via the internet. In initial categorization of references will also be provided to generate smaller databases. For example, references regarding water quality will be pooled into a subset. Additional divisions may include air quality, sediments, fisheries, groundwater, human health and others to be determined as the database grows. Each of these smaller databases will also be posted as searchable files on the internet. Finally, we will attempt to provide useful internet links to data regarding each of the categories. For example, the air quality subset would contain a link to The State of Florida's Department of Environmental Protection air quality pages (http://www.dep.state.fl.us/air/).

After the first six months of construction of the bibliography, we will begin to conduct an initial review to try to identify gaps in available information regarding environmental issues in Northwest Florida. In this way, resources may be directed toward topics for which additional information is still needed without continuing to conduct redundant studies.

Deliverables & Timeline:

Quarterly reports at three-month intervals
Months 1-12. Accumulation of references
Months 4-15. Completion of entries into Bibliography database
Months 7-18. Initial review of literature to identify gaps
Months 10-18. Construction of internet searchable database
Months 16-18. Review completed

Task 2. Assessing the Impact of Environmental Hazard Exposure on the Health Status Of Geographically Defined Populations in Escambia And Santa Rosa Counties. *(PI: J. Studnicki, University of South Florida)*

The extent to which exposure to environmental hazards of various types can be systematically correlated to variation in the health status of populations is the subject of continuing conjecture and research. Environmental contaminants in the air, water, work place and food supply have been linked to cancer, heart disease, birth defects and other causes of morbidity and mortality. For some contaminants, levels of exposure representing a health risk have been established from a combination of human and animal clinical toxicological studies. However, the health risk of any exposure is also related to multiple factors including the length and dose of the exposure, the susceptibility of the exposed person as determined by age, health history and other characteristics, and a myriad of other factors. A systematic and comprehensive association of hazardous exposures to population residing in geographically defined communities and variation in the health status of those populations can serve two important purposes. First, it can document the variation in the exposure to various contaminants across the variously defined "communities of interest" in Escambia and Santa Rosa counties. Second, it can determine whether this variation in exposures is related to variation in measures of health status, controlling for other factors known to influence morbidity and mortality such as age, race and poverty.

Objectives

The first objective of this project is to develop a series of indicators that can characterize Escambia and Santa Rosa Counties, and communities defined within those two counties, in terms of exposure to various environmental contaminants or hazards.

The second objective is to describe any socio-economic or demographic characteristics of these geographically defined populations that are associated with differences in the variation in exposures as defined in various ways.

The third objective is to associate these exposure levels with variation in health status. Beyond co-relational association, an important measurement challenge is to determine what component of variation in health status is statistically attributable to hazardous exposure levels and not other explanatory factors.

Approach

The environmental exposure indicators will be structured using variables that are currently available in extant databases. Among the data bases and example indicators would be: Toxic Release Inventory (pounds of chemical per year); National Emissions Inventory; AIRS Data (criteria pollutants); SESD (data base at the EPA laboratory in Athens, GA); hazardous waste (tons of waste by type per year); EPA Superfund sites (location, time in existence). Potential indicators will be analyzed for their utility in comprising an exposure index. Existing methodologies that utilize these exposure databases, existing standards, concentration levels and exceedance levels in order to produce comparative indices for counties or postal zip codes will also be assessed for their inclusion in the project. NATA and similar indices are good examples of existing comparative frameworks. The major advantage of using the existing comparative ratings is their immediate availability, allowing county level associations with existing indicators of population health status within a few months of the effective starting date of the project.

The various measures of health status are available in the unique data warehouse that has been constructed at the USF Center for Health Outcomes Research (USF-CHOR). The warehouse includes data from multiple databases (e.g., vital statistics, the Florida cancer registry, hospital discharge data and others) from multiple years. There are more than 300 indicators available at the county level, and about 2/3 of these indicators are also available at the postal zip code level. The major indicator categories (with example indicators from each category) are: Maternal and Child Health (birth defect mortality, infant mortality); Infectious Diseases (tuberculosis mortality); Physical and Environmental Health (lead poisoning cases, enteric disease morbidity); Health Status (heart disease, all cancer by site/type, stroke, chronic obstructive lung disease, pneumonia/influenza, and liver disease mortality); and Sentinel Events (avoidable hospitalizations). Many Demographic (age, race, rurality), Socioeconomic (per capita income) and Health Resource Availability (physicians, hospital beds per capita) characteristics are also available.

The major component of this research will be the development of a comprehensive environmental exposure risk profile. Our approach will be to utilize existing secondary data from the multiple sources, and we envision an iterative development process in which various indicators are analyzed, combined and modified based upon availability, currency, validity, association with or duplication of similar indicators, and other factors. There are three operational steps that must be accomplished in order to develop the exposure risk profile. First, all major types of environmental exposure domains (types) must be identified. For example, there are threats to the quality of the air, water supply, food supply and ground contamination.

Eventually, the profile would include all domains but we recommend concentrating on air quality during this one-year project period. Second, a comprehensive review of all existing data and the various methods utilized in developing indices from the data, will be completed. This effort will be coordinated with related activities in Tasks 1 and 3 described in the proposal.

A recent study demonstrated that the basic toxics database (EPA- Toxic Release Inventory) could produce varying estimates of spatially defined relative risk by applying different measures of toxicity (Cutter et al., 2002). Using the data from the State of South Carolina, six different methods were applied to facilities producing emissions: Threshold Limit Value (TLV), the Pratt Index (Pratt), the US EPA Priority Chemical List (USEPA PCL), the University of Tennessee Total Hayward Value (Total UTN), the Environmental Defense Fund (EDF) Toxicity Equivalent Potential (EDF TEP), and the EDF Modified Scorecard (Modified Scorecard). There was significant spatial variation in the indices by individual facility level. Third, an assessment of the available unit of analysis for each indicator will be undertaken. Data is typically available at some basic unit of granularity such as the producing facility. Often these indicators can be aggregated (rolled up) or disaggregated utilizing geographically defined units such as census tracts, postal zip codes, counties or regions. Based upon the statistical approaches to be utilized in this project, the conceptual and statistical advantages and disadvantages of these various approaches to various units of analysis will be reviewed, in an attempt to optimize the measurement power and flexibility of the exposure profile.

Work Plan

The project will require two major phases extending over a 12 month time period. Phase I will be the development of a geographically determined environmental exposure risk profile of Escambia and Santa Rosa counties. This phase will be accomplished using two separate approaches: 1) identification of "communities of interest" as determined by their location with respect to known sources of potential environmental contamination; 2) identification of variation in exposure to various contaminants based upon an analysis of indicators abstracted from extant data bases.

Phase II will be the analysis of variation in the exposure levels (as defined in two ways above) of geographically defined populations associated with variation in their health status. Major analytical goals in this phase are to: 1) characterize any differences in the socio-economic and demographic composition of populations in high exposure areas; 2) associate specific types of exposure with specific causes of morbidity and mortality; 3) quantify the independent effect of exposure on variation in health status.

The analytical strategy will involve analysis at two levels of focus. A county level analysis will allow for comparisons of the health status effects exposures in Escambia and Santa Rosa counties compared to other Florida counties and counties from other states, depending upon the availability of such national data. The second level of analysis will allow for a more precise definition of communities through the aggregation and analysis of data at the postal zip code level.

A retrospective longitudinal study design will be employed to investigate the association between selected measures of environmental exposure and selected measures of health outcomes. The study will utilize the CATCH-IT database, which combines data from a variety of sources including the Florida Vital Statistics files, the Florida Acute Hospital and Short-term Psychiatric Inpatient Data Collection, and the Florida Cancer Data System files (state-wide cancer registry file). Data is currently available at both the county and zip code level. This project will be conducted in two stages.

In the first stage, county level data will be analyzed. A series of general linear (or non-linear models depending on the nature of the data) models will be developed with health outcome measures (chronic disease death rates, incidence and death rate for cancers, rates of birth defects) included as the dependent variable while environmental exposure and demographic variables will be included as independent (explanatory) variables. An iterative process will be employed to identify the combination of independent variables, and possibly interactions between independent variables, that best predicts the outcome measure.

Each of these models will utilize data from a minimum of five years. Generalized estimating equations (GEE) will be employed to control for non-independence between data from successive years. GEE provides for efficient estimates of the coefficients and improved standard error estimates with repeated measures (Diggle, Liang and Zeger, 1994).

Results of the final models, will be interpreted after adjusting for potential inflation of experiment-wise alpha error due to multiple statistical testing. The modified Bonferoni approach as described by Holland and Copenhaver (1988), will be employed to maintain experiment-wise p values at $< = .05$.

In the second stage of the analysis one or more geographically contiguous "High Exposure Communities" will be identified (by grouping postal zip codes) from Escambia County. An attempt will be made to create "Synthetic Comparison Communities" from data available from all other Florida counties. To do this, zip codes from the remaining Florida counties will be matched to zip codes from the Escambia "High Exposure Community" by way of propensity scores (Smith, 1997).

Propensity scores will be calculated through a series of logistic regression equations that model county membership (Escambia versus Comparison County) as the dependent variable and important demographic variables as independent variables. Examples of demographic variables that will be employed include age, race and income.

Zip codes identified as being similar in demographic make up to the Escambia High Exposure Communities will be grouped into clusters of "Synthetic Comparison Communities". Such communities have the potential of being a smaller (more precise) unit of analysis to study the association between environmental exposure and health outcome measures.

It is hoped that as many as two or three comparison communities could be identified from each of the 66 Florida comparison counties. Such a pool of geographically based units would provide a much more powerful (at least from a statistical standpoint) platform for study of the association between environmental exposure and health outcome. A series of statistical analyses will be conducted to confirm the matching process has identified appropriate comparison communities. A description of the environmental measures across the comparison counties and communities will also be provided.

Expected Results

This project will produce a comprehensive environmental hazard exposure profile for Florida counties and communities defined at the sub-county level. The impact of these exposures on the health status of geographically defined populations within Escambia and Santa Rosa counties will be assessed. The population-based studies should serve as a screening analysis and pre-requisite for more detailed individual level research.

This project will also serve as the basis for a research program that can systematically link environmental indicators to the health status of geographically defined populations. One of the longer term challenges will be to develop a set of population health environmental indicators which will enable us to categorize the environmental impacts on human health. Of course, this is a complex process for many reasons. Environmental diseases can be defined in various ways, e.g. social (human interaction), community (type and place of residence), certain "external" factors (physical and biological) can all be termed as environmental in varying contexts. Definition and measurement of the range of environmental influences on health is a complex task. Our work in this project will be focused on various exposures which are involuntary as opposed to behavioral, and environment is primarily defined as external influences on health emphasizing air, water and soil quality, and biological factors such as vector-borne disease. Many diseases have multiple causes, many of which are still largely unknown. We know heart attacks and asthma, for example, have multiple causes, but environmental factors such as air pollution, heat and occupational stress are contributing influences. Ultimately, we hope to move to closely link environmental exposures to resultant disease state indicators. These correlations at the population level are called "ecological" epidemiological associations and are subject to causal inference errors due to the use of aggregated data (the ecological fallacy) where individual exposures are not assessed. Other problems may include measurement errors and confounding variables. Nonetheless, ecologic analysis is useful for generating hypotheses and illustrating confirmed linkages across a wide range of health status indicators. We realize that the statistical relationships evident from our assessments will only provide evidence that variation in health status may be associated with chemical exposures. Further studies (e.g., epidemiological evaluations) would have to be done to provide supporting evidence for the associations found.

Deliverables

Deliverable #1, at 6 months after the effective date of the contract, will be the exposure risk profile based upon the TRI data, selected toxicity indices currently available and appropriate for the research application, as well as any indices developed specifically for the application by the participating investigators.

Deliverable #2, at 12 months after the effective date of the contract, will be the report of the identified relationships of variation in exposure risk and population health status, utilizing the multiple measures of risk and multiple dimensions of health status.

Task 3. Air Quality Study: Phase I. (*PI: M.E. Chang, Georgia Institute of Technology*)

Evidence suggests that there are three types of air pollutants that may be affecting human health in the Pensacola, Florida area: air toxics, ozone, and particulate matter.

1. Air toxics are a class of pollutants known or suspected to cause cancer or other serious health effects in humans (e.g. reproductive effects or birth defects). While there are no federal or state air quality standards for these hazardous air pollutants, the United States Environmental Protection Agency (EPA) and the Florida Department of Environmental Protection (DEP) regulate the industrial emission of 188 pollutants identified as toxics in the Clean Air Act. Of the 67 counties in Florida, the 1999 Toxic Release Inventory (TRI) shows Escambia County (Pensacola) leading all others in total air toxics emissions

Table 2. 1999 Toxic Release Inventory (TRI), top ten county-level total air emissions in Florida (Toxic Release Inventory, US EPA, Office of Environmental Information, data update as of 1 August 2001).

Rank	County	Total Air Emissions (lbs/yr)

1.	Escambia	18,708,263
2.	Hillsborough	15,903,486
3.	Citrus	8,025,284
4.	Duval	7,525,546
5.	Polk	7,362,849
6.	Bay	6,579,631
7.	Putnam	6,216,633
8.	Nassau	2,486,199
9.	Palm Beach	2,413,461
10.	St. Lucie	2,302,906

2. Recent research shows that exposure to elevated concentrations of ozone can not only trigger asthmatic episodes in those previously diagnosed with the disease (Tolbert et al., 2001) but also lead to the development of the disease itself in otherwise healthy children (McConell et al., 2001). Other studies suggest that exposure to high ozone concentrations during pregnancy can lead to an increased risk of cardiac birth defects (Ritz et al., 2002). The EPA and DEP have implemented an air quality standard for ozone and at this time, every area in Florida is currently in attainment of this standard (as well as standards for the other five criteria pollutants: lead, sulfur dioxide, nitrogen dioxide, carbon monoxide, and particulate matter). At least two areas in Florida however, may fail to meet a new and more stringent standard for ozone that EPA plans to implement beginning in 2004. The 8-hour ozone NAAQS is exceeded when the 3-year average of the annual 4th highest 8-hour average ozone concentrations is greater than or equal to 85 parts per billion by volume (ppbv). At the McKinley Drive ozone monitoring site in Sarasota County, the average from 1999 to 2001 of the 4th highest annual 8-hour ozone concentrations (also called the "design value") was 85 ppbv. In Pensacola, the design value over this same period was 87 ppbv at the Naval Air Station site, and 85 ppbv at the Warrington site. For the period 1999-2001, no other monitors in Florida show design values greater than the 8-hour ozone NAAQS allows. ("8-hour Ozone Summary," State of Florida, Department of Environmental Protection, Division of Air Resources Management, 10/16/01). The latest (1999-2001) monitoring data from two sites in the

Pensacola area and one site in the Sarasota area show concentrations that exceed the new 8-hour ozone National Ambient Air Quality Standard (NAAQS).

3. In addition to the new ozone standard, the EPA plans to introduce a new NAAQS for fine particulate matter before the end of 2005. The Transportation Equity Act for the 21st Century (TEA-21) requires EPA to designate areas as attainment and non-attainment for fine particulate matter (PM2.5) by December 2005. Recent research shows that in some individuals, elevated concentrations of fine particles in the air can increase the risk of myocardial infarction (heart attack) within a few hours and up to one day after exposure (Peters et al., 2001). Longer-term exposure to these particles increases the risk of cardiopulmonary and lung cancer mortality (Pope et al., 2002). Data collected across Florida by DEP in 1999, suggest that only the Pensacola area may not meet this new standard. Fine particulate matter is defined as airborne particles having diameters less than 2.5 microns. The US EPA has promulgated an annual and a daily (24-hour) NAAQS for PM2.5. The annual standard is exceeded when the 3-year average of the annual average concentration is greater than 15.0 $\mu g/m^3$. The daily standard is exceeded when the 3-year average of the yearly 98th percentile daily values is greater than 65 $\mu g/m^3$. For

most of Florida, monitoring for PM2.5 began in 1999 (one sample collected every 3rd day) and no areas in 1999 showed concentrations higher than the annual or daily NAAQS. Pensacola however, began continuous PM2.5 mass measurements in 1998. Using this much more complete record, the annual PM2.5 average at the Ellyson Industrial Park site was 17.6 $\mu g/m^3$ in 1998, and several exceedances of the daily NAAQS were observed in 1999 ("Air Monitoring Report 1999," State of Florida, Department of Environmental Protection, Division of Air Resources Management). While the requisite 3-years of data are not yet available to determine compliance with the PM2.5 NAAQS, the early indications suggest that the Pensacola area may not meet one or both of the PM2.5 standards.

Based on its leading toxic air emissions, and its potential for non-attainment of the ground-level ozone and fine particulate matter NAAQS, none of Florida's inhabitants are potentially at greater health risk from air pollution than those residing in the Pensacola area. In recognition of these risks DEP, EPA, and local stakeholders have conducted regulatory activities and special studies to acquire information on the risks, origins, pathways, and effects of these pollutants. These include:

- The EPA's Toxic Release Inventory requires major industrial sources to report their annual estimated emissions of hazardous air pollutants. 1999 is the most recent year for which data are available.
- Monitoring of hazardous air pollutants in Pensacola's ambient air (Ellyson Industrial Park) was last completed in 1989 – 1990 by EPA and Radian.
- In Escambia County, the DEP routinely monitors for O_3 at two sites, SO_2 at two sites, PM_{10} at two sites, and $PM_{2.5}$ at two sites as part of its State/Local Air Monitoring Station (SLAMS) and National Air Monitoring Station (NAMS) Network.
- DEP has also recently conducted special purpose monitoring (SPM) in the Pensacola area for O_3 at one site, NO_2 at one site, and $PM_{2.5}$ at one site.

- The recently completed multi-stakeholder Gulf Coast Ozone Study (GCOS; draft report; Douglas et al., 2001) provides estimates of biogenic and anthropogenic NOx, VOC, and CO emissions, and simulated ambient concentrations of ozone resulting from baseline and alternative future emission scenarios.
- As part of the Southeastern Aerosol Research and Characterization (SEARCH) study, the Southern Company and Gulf Power are currently monitoring $PM_{2.5}$ mass and composition at two sites in the Pensacola area.

Independently, these information resources contribute to a better understanding about the risks, origins, pathways, and effects of air toxics, ground-level ozone, and fine particulate matter pollution in the Pensacola area. In aggregate, they also provide insight into the common sources, complex linkages, and compounding consequences shared by these pollutants. It is this latter holistic understanding that this study, herein described, seeks to contribute.

Work Plan:

Ideally, this study would be able to determine if there is a connection between airborne pollutants and observed morbidity or mortality in Pensacola. At the marginal to moderate concentration of current pollutant loads however, and combined with the relatively small population of the community, the effects of air pollution on human health in NW Florida are likely to be difficult, if not impossible to observe using traditional epidemiological approaches. This does not mean that the risk is negligible however. Based on studies from other communities (such as those underway or planned in Atlanta; e.g., (1) Study of Particulates and Health in Atlanta (SOPHIA) by Tolbert et al., or (2) Morehouse College, Emory University, and Georgia Tech (Hall et al.,) submitted a proposal to the National Institutes of Health on 2 February 2002 entitled: "Characterizing the effect of transient air pollutants on the health of African-Americans in Atlanta, Georgia." The experiences gained through these and other projects should be wholly relevant and transferable to the Pensacola area and through conservative screening models, risks can be estimated based on relative pollutant concentrations, emissions estimates, exposure patterns, and demographic distributions. The initial goal of this study then, will be to use the existing information sources to assess and prioritize local, urban, and regional threats to human health associated with air toxics and criteria pollutants in the Pensacola area (Phase I). Once this initial risk assessment is completed, a research strategy will be developed in full cooperation with all stakeholders and in consideration of all past and present efforts in this regard, that seeks to identify the effects, pathways, and origins of those pollutants that pose the greatest threats to the community (Phase II). Specific tasks for Phase I include:

1. Identify and assess all existing air data and evaluations to determine what is already known about air toxics and criteria pollutants in the Pensacola area. These studies will be coordinated with related bibliographic work in Task 1.

2. Determine and, if necessary and possible, enhance the quality of the local and regional emissions inventories for toxics, directly emitted criteria pollutants, and criteria pollutant precursors from anthropogenic and biogenic sources.

3. For air toxics, perform screening level analyses of existing air toxics data (e.g., National Air Toxics Assessment modeling, TRI Risk Screening Environmental Indicators,

   mercury air deposition modeling, etc…) and perform local screening level modeling with subsequent comparison to conservative health based standards to identify a set of chemicals and areas of potential concern for both direct and indirect exposure pathways. The outcomes would be communicated to the investigators of Task 2, for appropriate correlations.

4. Complete a health impacts literature search that includes the most recent findings, and in combination with criteria pollutant observations in the Pensacola, complete an assessment similar to 3 for the criteria pollutants that identifies potential concerns for both direct and indirect exposure pathways. The results would be communicated to the investigators for Task 2, for appropriate correlations.

5. In consultation with all stakeholders, and in particular those in the Pensacola area, prioritize needs and desires, evaluate the uncertainties and data gaps associated with the existing data and screening level analyses, and design long-term studies to more accurately assess the levels of pollutants in the environment, their sources, and their possible influence on adverse public health outcomes – taking into consideration the results derived from the overall project. This could include monitoring, meteorology, emission inventory and modeling studies, epidemiological, cohort and/or clinical studies, and risk assessments.

Deliverables

Biannual progress reports will be provided. Meetings for Community and Scientific Advisory Committees will be scheduled as requested. Other deliverables are described as follows.

Jul 2002	Project Kickoff / Organizational Meeting Selection of Community and Scientific Advisory Committees
Sep 2002	Survey of existing data and evaluations, and literature review complete
Dec 2002	Toxics and Criteria pollutant screening complete Six-month Progress Report
Apr 2003	Long-term studies proposals complete. Submit work plans (after QAPP approval by EPA) to EPA for review and approval before implementation of Phase II.
May 2003	Begin implementation of Phase II
Jun 2003	Annual Progress Report
Sep 2003	Phase II ends – Final Report or Continuation

Task 4. Assessment of Environmental and Health Impacts of Toxic Pollutants in Bayou Texar.
(*PI: J. E. Lepo, University of West Florida*)

Introduction and Background

Pensacola's Bayou Texar is located in southeastern Pensacola, Florida; its primary water input is from Carpenter's Creek, and the Bayou opens into Pensacola Bay. In addition to providing an attractive waterfront for much of the surrounding residential area, the Bayou is an important

recreational water body that has been used for water-skiing, motor boating, sailing, swimming, and fishing. Unfortunately, the Bayou suffers from degraded water- and sediment- quality due to pollution from multiple sources that contribute to the Bayou condition in ways and to degrees that remain unquantified and uncharacterized (see Ritchie et al., 2000).

Nearby EPA Superfund Sites in Pensacola, Florida, the Escambia Treating Company (ETC) and the Agrico Chemical Company (ACC) may also affect the quality of surface water of the Bayou, its sediments, and the ground water beneath it (See Figure 2). The contaminants of concern (COCs) for ETC include endocrine disruptive chemicals such as dioxins, pentachlorophenol (PCP) and PAHs. PCBs have been detected at the ETC at levels deemed below those posing human health concerns. The ACC is a former sulfuric acid and phosphate fertilizer production facility. Arsenic, lead, hexavalent chromium, and fluoride are the principal COCs. Other potentially toxic materials include vanadium and PAHs; the source of the latter may be the ETC site. Contaminated groundwater from these sites is moving toward the east-southeast, and fluoride from ACC has recently reached Bayou Texar (Figure 2; CDM Federal Programs Corporation, 2000; 2002). People who eat fish or shellfish from this area may be at risk from other COCs in the future. This fact is an issue of major concern among regional citizens groups, city and county leaders, and environmental regulators.

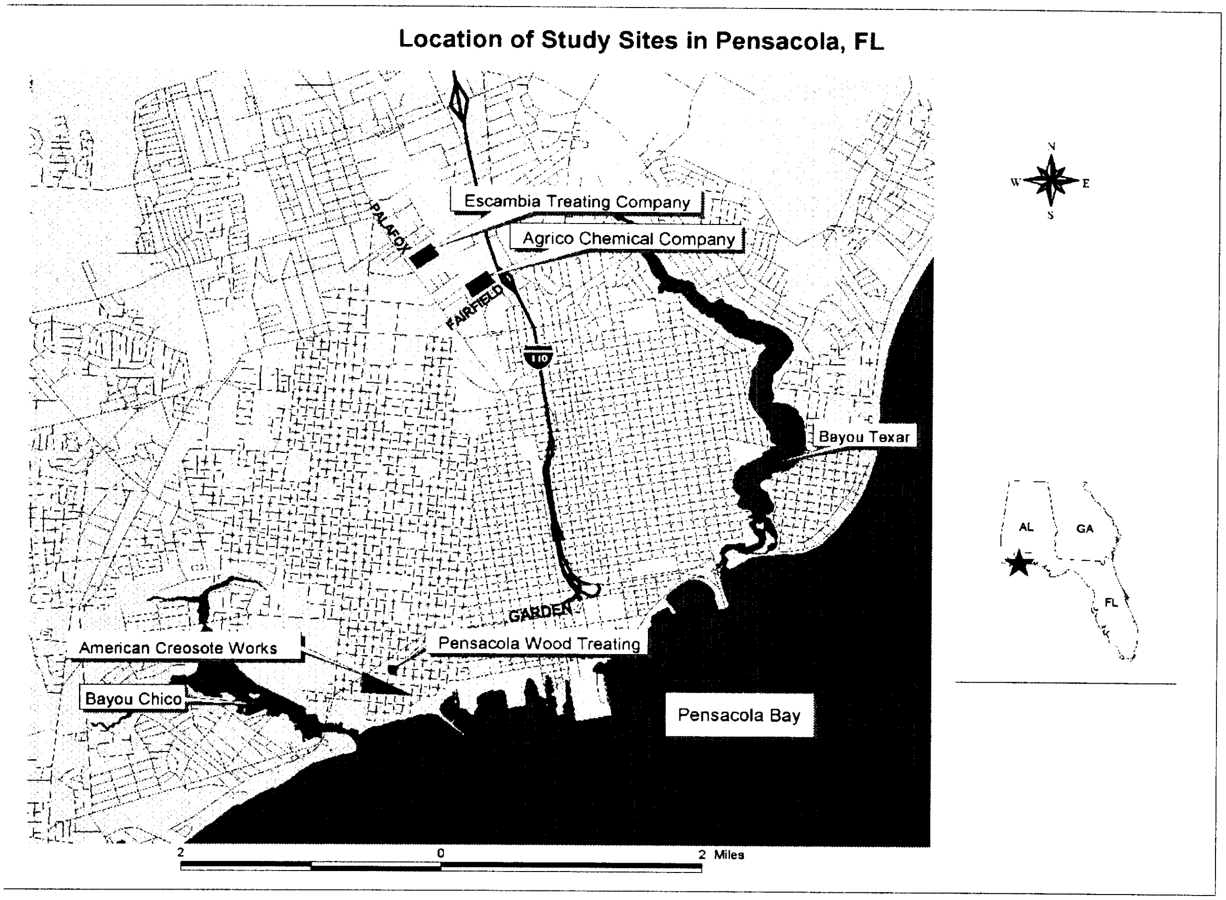

Figure 2. Location of Bayou Texar

The Bayou is affected by multiple pollutants. For instance, the Bayou is frequently contaminated by excessive fecal indicators (fecal coliform bacteria, enterococci; Escambia County Health Department data 2000 - present). High nutrient levels in Bayou Texar waters are common, probably fed by stormwater runoff from residential lawns. Stone and Liebens (1997) found high concentrations of heavy metals (notably Cu, Pb, Zn, Cd) in Bayou Texar sediments. Recently, Lewis and coworkers (2001) found substantial levels of polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and other toxic substances in Bayou Texar sediments. All of the sediment studies are based on a very limited sampling base, in most cases three or four sites within the 370-acres covered by the water body, and at one level within the sediment. Thus, the geographical and vertical spatial extent of contamination is not well defined.

The primary or contributing sources for most of these pollutants are unknown. Such pollutant loads impair the use of Bayou Texar as a recreational water body. Exposure of the public may occur via contact with contaminated water and sediments, and fish harvested from the water body possibly bare bioaccumulated concentrations of some pollutants found in the sediments. Moreover, currently proposed remedial plans for the Bayou include dredging to improve flushing. If this were to be implemented, then pollutants such as PCBs and PAHs, currently sequestered by tight binding to sediments, could be released into the water column; the disposal of organic- and metals-contaminated spoils of dredging might also be problematic.

Purpose/Rationale

Because of a limited number of sampling sites in and near Bayou Texar, and a limited spectrum of analyses for potential COCs, there is incomplete information relative to the geographical extent and degree of environmental pollution. Such information is essential to assessing the potential exposure of human populations to toxic chemicals and environmental threats to adjacent water bodies. This project will consider all existing information, and does not seek to repeat any existing relevant information available from EPA-conducted studies of these sites. The purpose of the study is to identify and fill existing data gaps for a more complete assessment of the state of the Bayou and provide predictive capability for remedial efforts.

Because of the economic, aesthetic, and environmental importance of the Bayou, and the uncertainties surrounding source of pollution problems and courses of remedial action, the water body remains a focus of concern for citizens of Pensacola. Moreover, Bayou Texar should serve as a model system for the study of combined multiple sources of pollution.

Work Plan

Phase I. *Spatial correlation of existing environmental data and potential exposure using GIS mapping; development of QAPP (First 6 months)*

The existing data from Public Health Assessment studies, EPA-mandated studies and records of decision will be used to profile the location and concentrations of COCs emanating from ACC and ETC as threats to water and sediment quality of Bayou Texar. This information will be incorporated into a geographic information system (GIS) database to provide spatial correlation of environmental data and potential exposure of indigenous populations to COCs via a variety of routes of exposure. The GIS will also serve as a link to hydrogeological groundwater flow models and will assist in prioritizing future research efforts.

Digital maps with the local road network, land use /land cover, and administrative subdivisions will be used as the background for the compilation of the GIS database. Existing hardcopy data on the location of monitoring, irrigation, and drinking water wells, geological features, surface and subsurface hydrology, toxic plume location, and water and sediment pollution data will be imported and mapped in the GIS. Import techniques will depend on the format of the data but will include digitizing, scanning, heads-up digitizing, and event theme import. Tables with analytical results for COCs in wells, sediments and surface water will be joined to the maps and assigned to the corresponding sampling site. Subsequently, continuous-surface maps for the COCs will be generated to depict and analyze their spatial distribution. Information from the newly obtained maps will serve as input for a 3D groundwater flow and solute transport model that will allow assessing of future dispersal of the COCs, and thus will introduce a temporal dimension to our study.

Phase II. *Additional sampling and chemical analyses as needed to fill data gaps. (from month 6 through month 15)*

Data gaps will be identified through the GIS databases, consultation with EPA and with regional environmental officials. A further consideration is that the current complement of COCs may also be changing with time due to groundwater intrusion and surface runoff and other processes. The current database may reveal a lack of sampling stations at critical sites within and surrounding Bayou Texar and may require installation of additional groundwater wells, additional sampling of existing wells, and sediment sampling within and about Bayou Texar. Allowances will also be made for potential soil samples in the watersheds draining into Bayou Texar to identify additional sources. Preliminary assessments will be made to determine whether there are pollutants (VOCs) that could be emitted from the underground plume that might infiltrate homes. Discovered inadequate analysis of COCs at particular existing sampling sites will result in supplementary analytical chemistry work, and some of the assessments may have to be done in the future.

Prior to initiating sampling and analytical chemical work, we will develop a Quality Assurance Project Plan (QAPP). Sampling and analyses will be conducted by the CEDB's Wetlands Research Laboratory (WRL), a State-Certified, National Environmental Laboratory Accreditation Program (NELAP) compliant, water-quality laboratory (See Facilities and the Quality Assurance Statement).

The WRL routinely assesses all the COCs relevant to this project with the exception of dioxins. As appropriate, site materials will be analyzed for PCBs, PCP, PAHs, pesticides (e.g., dieldrin), metals (e.g., arsenic, lead, chromium), hydrocarbons, and fluoride. When indicated by the Phase I GIS databases, dioxins (2,3,7,8 tetrachlorodibenzo-*p*-dioxin [TCDD] or dioxin-TEQ) will be analyzed by high resolution GC/MS according to EPA Method 1613 through the services of American Institute of Toxicology Laboratories, Indianapolis.

Phase III *Predictive models for future impacts on Bayou Texar. (from month 12 through month 18)*

Known physico-chemical parameters on the relative mobility of COCs within groundwater and sediments, and with respect to their degradability can be used to predict the fate of COCs within Bayou Texar water and sediment. Using the Phase I GIS database and considering hydrogeological influences and spatial distribution, potential threat to human populations and exposure via Bayou Texar will be addressed.

Factors to consider include rates of sediment deposition from stormwater runoff from adjacent lands and input from Carpenter's Creek. Some COCs will increase in concentration as ETC and ACC plumes migrate in from beneath the Bayou; others may decrease in concentration, if volatile or degradable. Residence time (half-life) in Bayou of COCs may be estimated through an iterative monitoring process and will allow evaluation of approaches to treatability, including bioremediation, where such may be considered as feasible. The Northwest Florida Water Management District (NWFWMD) has developed a computer-based, 3-D model of groundwater flow within the sand and gravel aquifer. Although this model does not consider chemicals, it may be used in conjunction with known physico-chemical properties of COCs such as solubility, volatility, to develop predictive paradigms for Bayou Texar. For example, one would not expect PCBs and high molecular weight PAHs to be carried as soluble components of groundwater unless the flow included particulate matter to which these COCs could be bound.

Expected Outcomes

Evaluate the relative contribution of potential sources of pollution: (stormwater runoff from lawns and roads, input from Carpenter's Creek and other point-source outfalls, and polluted groundwater from industrial sites such as ACC and ETC, and tidal influx from Pensacola Bay).

If, during the mapping of the location of COCs in Bayou Texar's sediments, we find high concentrations of PAHs or other COCs near the mouth of the Bayou, we would collect and analyze samples of water flowing from Pensacola Bay during the incoming tide. If the COCs are in low concentration in these samples, we would judge that tidal influx is a negligible contributor to such pollution.

Assess threat of Superfund Sites to water and sediment quality in Bayou Texar and indirectly to potentially exposed human populations.

Assess potential for synergistic effects on Bayou Texar from the mixing of ECT and ACC plumes.

Map proximity of groundwater plumes to existing wells (private and public), and estimate level of contamination at/near those wells.

Provide predictive capability for future of water quality after remedial action (using the NWFWMD 3-D model and our updated GIS databases), including:

a. Potential detrimental effects of dredging Bayou Texar such as release of sediment-bound PCBs and PAHs and requirements for disposal/stockpiling of dredge spoil (requirements depend on level and type of pollutant);
b. Potential for remedial approaches for some pollutants (e.g., natural attenuation, biological, dredging);
c. Evaluate meteorological influences (e.g., rainfall, prevailing winds) on distribution of COCs, and serve as a link to hydrogeological groundwater flow models.

Time Line and Deliverables

Phase I	Spatial correlation of existing environmental data and potential exposure using GIS mapping; submit QAPP for approval by EPA before any sampling is initiated.
Phase II	Sampling and chemical analyses as needed to fill data gaps (initiate at 6 months, continue 9 months to 15 months).
Phase III	Predictive models for future impacts on Bayou Texar (initiate at 12 months, continue to 18 months).

Quality Assurance Project Plan: Submitted before the initiation of Phase II
Quarterly Reports: Submitted at 3-month intervals
Final Report: Submitted within 90 days after completion of project

Task 5. Project Coordination and Implementation. (*PI: K. Ranga Rao, University of West Florida*)

The Center for Environmental Diagnostics and Bioremediation (CEDB) is the organizational unit at the University of west Florida that will be responsible for the overall coordination and management of this project under the supervision of Dr. K. Ranga Rao who will serve as Project Director. The CEDB has a proven record of securing competitive grants from diverse federal agencies and ensuring productive outcomes. Dr. Rao has extensive administrative experience (12 years as Director of CEDB; 4 years as Dean of the College of Science and Technology) and substantial research experience--serving as Principal Investigator and Project Director for a number of federal grants during the past 30 years. As Project Director for the current project, Dr. Rao will interface with the EPA's Project Officer and technical staff and supervise the implementation and progress of the various tasks, including coordination of the submission and approval of QA/QC plans and protocols as needed.

In order to ensure coordination among project elements, all participating investigators will meet at the beginning of the project and at least two additional times during the course of the project and also engage in quarterly conference calls to discuss the implementation and progress of the project as well as to identify any problems encountered and corrective actions to be taken. The Project Director will coordinate these meetings and report the outcomes to the EPA Project Officer. The Project Director will review progress reports and publications for all tasks, and communicate the outcomes to the EPA Project Officer.

Timeline and deliverables:

1. Initiation of the Project: July 2002.
2. Establishment of Subgrants: August 2002.
3. Quarterly Reports: To be submitted at 3-month intervals during the project period, with the first report due by November 15, 2002.
4. Final Report: To be submitted within 90 days after the completion of the project period.

REFERENCES

ATSDR, PHA, ETC. 1995. Public Health Assessment (PHA) by the Agency for Toxic substances and Disease Registry (ATSDR) of Center for Disease Control and Prevention for Escambia Treating Company Superfund Site. http://www.atsdr.cdc.gov/HAC/PHA/escambia/esc_p1.html.

ATSDR, PHA, ACC. 1995. Public Health Assessment (PHA) by the Agency for Toxic Substances and Disease Registry (ATSDR) of Center for Disease Control and Prevention for Agrico Chemical Company Superfund Site. http://www.atsdr.cdc.gov/HAC/PHA/agrico/agr_p1.html.

CDM Federal Programs Corporation. 2000. Phase I Data evaluation report: Remedial Investigation/Feasibility Study for the Escambia Treating Company Site Operable Unit 2 Pensacola, Florida December 1, 2000. Prepared for U.S. Environmental Protection Agency Region IV.

CDM Federal Programs Corporation. 2002. Phase II Data evaluation report: Remedial Investigation/Feasibility Study for the Escambia Treating Company Site Operable Unit 2 Pensacola, Florida To be released in 2002. Prepared for U.S. Environmental Protection Agency Region IV.

Cutter, S.L., M.S. Scott, and A.A. Hill. 2002. Spatial variability in toxicity indicators used to rank chemical risks. *Amer. J. Public Health* 92:420-427.

Diggle, P.J., Liang, K.Y., Zeger, S.L. 1994. *Analysis of Longitudinal Data.* Oxford: Oxford University Press.

Douglas, S.G, Y. Wei, A.B. Hudischewskyj, A.R. Alvarez, R.S. Beizaie, and J.L. Haney. 2001. "Gulf Coast Ozone Study (GCOS) Modeling Analysis: Phase II: Methods and Results, Draft; July 20, 2001.

Grand Jury Report. 1999. Report of the Special Grand Jury on Air and Water Quality. First Judicial Circuit of the State of Florida. Escambia County, Florida. June 10, 1999.

Holland, B.S. and Copenhaver, M.D. 1988. Improved Bonferoni-type multiple testing procedures. *Psychological Bulletin.*104:145-149.

Knight, J., A. Bahtijareviv, and T. Pratt. 1996. Phase 1 Evaluation of impacts to ground water quality from agricultural usage areas of Escambia and Santa Rosa Counties. Florida Department of Environmental Protection, Water Resources Special Report 96-6.

Lewis, M.A., J. C. Moore, L. R. Goodman, J. M. Patrick, R. S. Stanley, T. H. Roush, and R. L. Quarles. 2001. The effects of urbanization on the chemical quality of three tidal bayous in the Gulf of Mexico. Water, Air and Soil Pollution. 127:65-91.

McConnell, R., K. Berhane, F. Gilliland, S. J. London, T. Islam, W. J. Gauderman, E. Avol, H. G. Margolis, and J. M. Peters. 2002. Asthma in exercising children exposed to ozone: a cohort study, *The Lancet*, 359: 386-391.

Means, S., and A. J. McErlean. 1987. An Environmental Bibliography of Northwest Florida. US Environmental Protection Agency, Gulf Breeze, FL.

Peters A., D. W. Dockery, J. E. Muller, and M. A. Mittleman, 2001. Increased Particulate Air Pollution and the Triggering of Myocardial Infarction, *Circulation,* 103:2810-2815.

Pope, C. A., R. T. Burnett, M. J. Thun, E. E. Calle, D. Krewski, K. Ito, and G. D. Thurston. 2002. Lung Cancer, Cardiopulmonary Mortality, and Long-term Exposure to Fine Particulate Air Pollution, *JAMA*, 287:1132-1141.

Ritchie, B., et al. 2000. Report of the Citizens' Task Force on Urban Stormwater Runoff J. E. Lepo: Technical Liaison and Writer. Published by Escambia County, City of Pensacola, Escambia County Utilities Authority, 21 March 2000. (see report at: http://uwf.edu/whitcntr/)

Ritz, B., F. Yu, S. Fruin, G. Chapa, G. M. Shaw, and J. A. Harris. 2002. Ambient Air Pollution and Risk of Birth Defects in Southern California, *Am J Epidemiol*, 155: 17-25.

Smith, H.L. 1997. Matching with multiple controls to estimate treatment differences in observational studies in Sociological Methodology 1997, ed AE Raferty. Oxford: Basil Blackwell. 325-353.

Stone, G. W., and J. Liebens. 1997. Continuation of biophysical monitoring at Bayou Texar: bathymetric, sedmentological and macroinvertebrate evaluation at twelve outfalls. Institute for Coastal and Estuarine Research, The University of West Florida; Report to Escambia County, Florida.

Streater, S. 2001. Hidden Hazard. Pollution puts many people at risk every day. *Pensacola News Journal*. February 18, 2001.

Studnicki, J. 2001a. "Santa Rosa County 2000." Comprehensive assessment for tracking community health, Santa Rosa County, Florida – Final Report.

Studnicki, J. 2001b. "Escambia County 2000." Comprehensive assessment for tracking community health, Escambia County, Florida – Final Report.

Tolbert, PE, JA Mulholland, DL MacIntosh, F Xu, D Daniels, OJ Devine, BP Carlin, M Klein, J Dorley, AJ Butler, DF Nordenberg, H Frumkin, PB Ryan and MC White. 2001. Air quality and pediatric emergency room visits for asthma in Atlanta, Georgia, USA, *American Journal of Epidemiology*, Vol 151, Issue 8 798-810.

FACILITIES

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The Center for Environmental Diagnostics and Bioremediation (CEDB) at the University of West Florida (UWF) currently has office space (administrative office suite and individual faculty offices) as well as research laboratory space (five labs, with total space of ~3,500 sq. ft.) located in the biology-chemistry building. The offices are equipped with Pentium-class personal computers (or equivalent MacIntosh), and printers (laser and color). All faculty computers at UWF are fully networked with each other and the Internet. Local PCs are equipped with software for word processing, database management, spreadsheets, graphics, and statistics. UWF's Information Technology Services (ITS) personnel provide additional support for software and hardware. The CEDB faculty research laboratories are equipped to carry out research in the areas of microbial ecology, biochemistry, genetics; molecular biology; oceanography; estuarine ecology; biological surveys; plant community analysis; environmental toxicology; assessments of environmental pollution; and bioremediation feasibility and technology development. Additional general facilities available in the biology-chemistry building include: radiochemistry laboratory, analytical chemistry laboratory with fume hoods, flammable materials storage facility, electron microscopy laboratory, darks rooms, walk-in environmental chambers and cold rooms, dish-washing facilities, autoclaving facilities, biological and radiochemical waste disposal services, and a stock room for general glassware and chemicals.

The CEDB's Facilities include a separate ~2000-sq. ft Wetlands Research Laboratory (WRL), which is State of Florida Certified for environmental water analysis (Lab ID: E71176) and complies with full chain of custody sample storage and handling practices (Comprehensive Quality Assurance Plan for Florida HRS: CompQAP #870431; conforming to Florida State Department of Environmental Protection and the U. S. Environmental Protection Agency standards). The WRL is equipped with pH meters, fluoride-ion-specific electrode, ovens, incubators, a muffle furnace, analytical and top-loading balances, autoclave, block digesters, sonicator, research-grade (Leica) compound and dissecting microscopes, three Hewlett-Packard gas chromatographs (5890 Series II) with flame-ionization-, electron capture-, electrolytic cell-, and photo-ionization- detectors and autosampling with Chemstation control, a Hewlett-Packard HLPC system, a GC-Mass spectrometer (Finnigan/Thermoquest Trace 2000) with autosampler and Tekmar purge and trap, a Milton Roy 20D UV-Vis spectrophotometer, Varian SPECTRAA 220FS flame atomic absorption spectrometer (AAS), Varian SPECTRAA 220Z Zeeman furnace AAS, Dionex DX500 ion chromatograph, Bran & Luebbe AutoAnalyzer-3 nutrient analyzer, CTAC Technologies M-6000A Cold Vapor mercury analyzer with auto sampler, and ThermoFinnigan /1112 Series EA C-N analyzer. Field equipment includes: Dodge Ram Van (1996), a Ford Bronco II (1988), 28- ft pontoon boat, two Jon boats and a 200-hp, 26-ft Cape Horn Center-console craft capable of sampling up to 20 miles offshore. WRL also has gasoline powered field generators, an enclosed 24-ft mobile lab, and a 15-ft open trailer with 200-gallon water tank, and sediment coring equipment.

The CEDB researchers and the co-PI Dr. Johan Liebens (Department of Environmental Studies) have full access to the GeoData Center, a university-wide GIS laboratory, at the University of West Florida. The Center has the following facilities: (1) A dedicated Dell Windows 2000 Server with dual 600 MHz processors, 128 GB hard disk, and 512 MB RAM; (2) Twenty new Dell Pentium IV PC workstations with large-size screens running Windows NT/2000; (3) Fast Ethernet (100BaseT) network wiring throughout the lab, 3COM 3300 switches and centralized network management; (4) Two large format digitizers (Accutab and Kurta) and five small format CalComp Drawing Boards; and (5) One GIS-grade Trimble differential GPS receiver.

Equipment for analysis of data in film or hardcopy format includes Hewlett Packard ScanJet ADF scanners, light tables, and reflecting projectors. Hardcopy output is provided by a wide-format Hewlett Packard DesignJet 755cm, HPLaserjet III, and HP 8550 Color Laser Jet. Major GIS software packages include ESRI ArcInfo, ArcView, ArcIMS, and ESRI's latest GIS product ArcGIS 8.1.2, ERDAS Imagine, and IDRISI. In addition, the GeoData Center also houses a wide array of GIS databases from different sources.

QUALITY ASSURANCE STATEMENT

We have extensive experience in complying with the quality assurance (QA) requirements of the U. S. Environmental Protection Agency (EPA). The University of West Florida's Center for Environmental Diagnostics and Bioremediation (CEDB) includes the Wetlands Research Laboratory (WRL), an environmental-water-quality laboratory. The WRL is State-of-Florida Certified for Environmental-Water analyses (Lab ID: E71176) and the laboratory complies with full chain of custody sample storage and handling practices (the WRL Comprehensive Quality Assurance Plan for Florida HRS: #870431), conforming to Florida State Department of Environmental Protection and the U. S. EPA standards. The WRL also complies with the National Environmental Laboratory Accreditation Program (NELAP) through the State of Florida NELAP certification authority.

These same standards of sample handling and data quality assurance will apply to work conducted at all levels of this project, including the work to be performed by subgrantees. Below we outline the QA for this project, which will be backed up by a comprehensive QA Project Plan (QAPP) as the project is implemented, and will be available to the EPA Project Officer for review and approval.

1. Activities to be performed/ hypothesis to be tested.

There are four activity components to this project. Each has unique QA/QC requirements; refer to project descriptions for details of approach.

a) *Construction of an Environmental Bibliography for Northwest Florida*

This activity is not amenable to conventional QA/QC practices, but sufficient care will be exercised to ensure that appropriate literature sources are attributed, and that the type of source and level of scientific rigor is noted (e.g., peer review, private contract report, EPA project report).

b) *Assessing the Impact of Environmental Hazard Exposure on the Health Status of Geographically Defined Populations in Escambia and Santa Rosa Counties, Florida*

This activity will also involve collation and analysis of data from existing databases, and as such is not amenable to conventional QA/QC. Care will be exercised to ensure validity and to qualify reliability of data when appropriate. The project will develop a series of indicators that characterize Escambia and Santa Rosa Counties, and communities defined within those two counties, in terms of exposure to various environmental contaminants or hazards and describe any socio-economic or demographic characteristics of these geographically defined populations which are associated with differences in the variation in exposures as defined in various ways. Finally, we will associate these exposure levels with variation in health status. The project seeks to determine components of variation in health status that are statistically attributable to hazardous exposure levels, excluding other explanatory factors.

c) *Air Quality Studies*

This component will identify and assess existing air data and evaluations to determine what is already known about air toxics and criteria pollutants in the Pensacola area. It will enhance the quality of regional emissions inventories for toxics, directly emitted criteria pollutants, and criteria pollutant precursors from anthropogenic and biogenic sources; perform screening level analyses of existing air toxics data with subsequent comparison to conservative health based standards to identify a set of chemicals and areas of potential concern for both direct and indirect exposure pathways. For air toxics, this project component will perform screening level analyses of existing air toxics data and perform local screening level modeling with subsequent comparison to conservative health based standards to identify a set of chemicals and areas of potential concern for both direct and indirect exposure pathways. The project will complete a health impacts literature search relevant to pollution in the Pensacola area. In consultation with stakeholders, in particular those in the Pensacola area, it will prioritize needs and desires, evaluate the uncertainties and data gaps associated with the existing data and screening level analyses, and design long-term studies to more accurately assess the levels of pollutants in the environment, their sources, and their possible influence on adverse public health outcomes.

d) *Assessment of Environmental and Health Impacts of Toxic Pollutants on Bayou Texar*
This project component will evaluate relative contribution of pollutant sources to water and sediment quality in Bayou Texar; such sources include stormwater runoff from lawns and roads, input from Carpenter's Creek and other point-source outfalls, polluted groundwater from former industrial sites (e.g., Agrico Chemical Company and Escambia Treating Company) and tidal influx from Pensacola Bay. The project will assess potential for synergistic effects of groundwater pollutant plumes on Bayou Texar. Indirectly, the study should provide additional information concerning the threat posed by pollutants of all sources to exposed human populations. Phase 1 will map the location of current pollutants, the proximity of groundwater plumes to existing wells (private and public), and estimate level of contamination at/near those wells. Phase 2 will fill sampling and analytical chemistry data gaps. Phase 3 will provide predictive capability for future of water quality after remedial action (using a 3-D computer model and our updated GIS databases), including: the potential detrimental effects of dredging Bayou Texar such as the release of sediment-bound PCBs and PAHs and the requirements for disposal/stockpiling of dredge spoil (requirements depend on level and type of pollutant). Groundwater flow modeling will be employed and potential remedial approaches may be suggested for some pollutants. Where applicable, hypotheses will be tested by analysis of laboratory data, existing field data (from EPA mandated studies) and data collected from additional sampling. Geographic Information System (GIS) modeling and groundwater flow modeling will be accomplished for Bayou Texar.

Quality Assurance Objectives for Measurement Data will include: *Precision,* ensured through sufficient replication and standard quality control (QC) procedures for analysis of chemical analytes and biological parameters; and a*ccuracy* in the analysis of chemicals and other parameters (e.g., DO, nutrients, suspended solids) will be ensured by reference to commercially obtained, analytical grade, primary standards or standard reference materials. Five point calibration curves using chemical standards will be used to establish concentrations and detection limits for individual analytes.

Completeness will be ensured by paying particular attention to documentation of metadata that place raw data in a meaningful context. The application of rigorous criteria for complete data sets that adequately support the theses of these publications will be absolutely essential. To ensure that results are *representative*, multiple sites, and material obtained from them (e.g., sediments, water) will be assessed to ensure that laboratory findings represent field conditions. Subcontracting institutions for this project will be bound by the same standards of Quality Assurance and Quality Control as are specified in this QA Statement and within the Comprehensive Quality Assurance Project Plan under which the CEDB/WRL laboratory operates. *Comparability* will be established by making our findings available to the scientific community allowing replication in other laboratories and field environments. The supporting analytical methods (e.g., any analytical chemical support) will be by standard methods. Standard operating procedures (SOPs) will be followed for many of these methods, and new SOPs will be developed as necessary and will be incorporated into the QAPP. The project's primary output will be: scientific knowledge, publishable in reviewed professional journals and formal reports to the funding agency (EPA).

2. Study Design and Statistics. There will be sufficient replication incorporated in experimental designs to define variability and permit statistical comparisons. For supporting analytical data, appropriate statistical models (regression, ANOVA, PCA, etc) will be used. Data sets will be tested for conformity to the basic assumptions of the appropriate statistical test. Significant differences are defined as $P \leq 0.05$, or the variability defined by control replicates as appropriate. Field data for this project will be incorporated into a GIS database maintained at the University of West Florida; all data will be maintained on network servers that have automatic drive mirroring such that all databases are automatically backed up on separate server drives.

3. Sample Handling, Custody, ID. All environmental samples will be collected in accord with the WRL Comprehensive QA Plan and NELAP certifications (as defined in the introductory paragraph) and with chain-of-custody control. This project is not litigation-related. Quality control is necessary to establish the validity and credibility of the study. Range and consistency checks will be part of the data entry software. Data will be examined for outliers. We will look for trends with study time with respect to all measures. Samples will be assigned unique identifying numbers recorded on a sample tracking form prior to analytical chemical analyses for target analytes (e.g., NO_3, NH_3). A sample logbook will be kept in each participating laboratory for recording location, date and time of collection. Tracking forms will be completed as samples are processed, and supervisors will note the completion of quality control procedures appropriate to each sample (e.g., acid preservation or refrigeration of samples). All samples will be logged into a computer database (Microsoft Excel™ or Microsoft Access™ as needed) dedicated to the project. The WRL utilizes a Laboratory Information System (LIMS; Lablite2000™) based on Microsoft Access™ with multiple data backup features; for this project, data from the LIMS will also be backed up on the UWF network server on independent mirrored drives. The WRL certifications (described in the first paragraph) include the use of freezer and refrigerator log books to keep track of how samples were stored, and instrument log books for keeping track of instrument conditions and calibrations. *Only project personnel* will handle samples generated within this project.

4. Calibration and performance evaluation will be performed using a number of replicates appropriate for the experimental design. Instrumental Calibration and Performance Evaluation will be done by the WRL, a State-certified laboratory (see Facilities, in the Project Description, and the introductory paragraph of this QA Statement), for all analytes and microbial methods used in

this project and to support development of a new method. Analytical instruments are on service contract; internal QC work is done to maintain certification. The same QC procedures and performance standards will be applied all instrumental analyses associated with this project.

5. Data Reduction, Validation, and Reporting are the final responsibility of the Principal Investigators who will generate required reports and publications from each of the component projects. All technical personnel will record data either in double-entry laboratory notebooks or electronically from the analytical instruments and through the LIMS; in the latter case some data reduction is possible at that stage. All electronic data will be archived on network servers within the UWF network server on independent mirrored drives.

Use of Data: Once data have passed a QA/QC screening they will be incorporated into GIS databases, statistical analyses, reports to EPA and ultimately peer-reviewed publications as appropriate. Our research will produce data pertinent to the assessment of environmental health and community health. Such data can be used to perform multi-screen risk analysis, to develop long-term monitoring plans, and to implement measures to improve environmental conditions and community health.

6. Project Success Criteria. Success is to unequivocally affirm or negate project hypotheses where appropriate, or to complete the stated activity goals as described in section 1 of this QA Statement. Our principal goal is to establish a reliable database (including an inventory of available data, and generation of new and refined data) on environmental pollutants and their sources, so that the data can be used in future work to assess cumulative risk from multiple sources in the Pensacola area. The success of our efforts can be measured by the completeness of the compilation of existing data, and by the quality of any new and refined data and analysis resulting from the project. In order to ensure orderly progress, periodic review of progress (on a quarterly basis) involving all of the participating investigators and consultation with other knowledgeable peers and members of the advisory committee will be carried out, so that corrective actions can be taken in a timely fashion. Difficulties in assessing previously collected data, delays in recruiting personnel, potential breakdown in equipment, and other unforeseen factors may impede progress. Such problems and corrective actions will be reported to the Project Officer.

We realize that, although the proposed tasks for the current project will yield deliverables as identified in the proposal, the ultimate goal of enabling stakeholders to account for and assess potential health effects of multiple contaminants from multiple sources would require further studies, including epidemiological evaluations and the application of emerging methodologies in risk assessment modeling (e.g., RAIMI, Regional Air Impact Modeling Initiative).